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### Working Paper Comparative Advantage in the 24/7 Economy: Time-Zone Differences and Service Trade Flows

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# CESIFO WORKING PAPERS

# Comparative Advantage in the 24/7 Economy: Time-Zone Differences and Service Trade Flows

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### Comparative Advantage in the 24/7 *Economy*: Time-Zone Differences and Service Trade Flows

### Abstract

Traditional gravity models posit an inverse relationship between geographical distance and bilateral trade due to increased transportation costs. However, recent literature suggests that bilateral service trade may increase between two countries located at an appropriate geographical distance. Using the Poisson Pseudo-Maximum Likelihood (PPML) method, this research analyses two key effects of time difference for 162 countries in 2018 - the continuity effect (enabling 24/7 operations) and the synchronization effect (influenced by cultural and/or institutional differences) for aggregate services, ICT-enabled services, and travel-transportation services. Our findings indicate a positive continuity effect across all service categories, while the synchronization effect varies across categories. We also find that 8-10 hour time difference between two countries appears most advantageous for ICT-enabled service trade between them. This paper underscores the importance of ICT and physical infrastructure, coupled with transparent governance, to boost service trade.

JEL-Codes: F100, F140, L860.

Keywords: service trade, time zone difference, continuity effect, synchronization effect, information and communication technology (ICT).

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### 1. Introduction

The gravity model of international trade postulates an inverse relationship between bilateral trade flows and geographic distance, due to rising transaction costs. Advancements in technology have diminished the impact of physical distance on international trade, though this distance elasticity varies across countries of different income levels, as evidenced by Borchert and Yotov (2017) for 69 countries from 1986 to 2006. The widespread adoption of information and communication technology (ICT) has steadily reduced distance-induced barriers.<sup>1</sup> Contemporary technological advancements, encompassing mobile connectivity, satellite communication, and high-speed internet infrastructure, have facilitated the disaggregation and outsourcing of services. This phenomenon has significantly augmented the tradability of previously non-traded services, reshaping the landscape of global trade dynamics (Mandal et al., 2017).

In recent decades, there has been a notable upward trajectory in both aggregate service trade and ICT-enabled services. Figures 1 and 2 illustrate the export-import patterns of overall services, while Figures 3 and 4 represent ICT services specifically for a selection of representative developed and developing nations to global trade.



Source: World Bank

<sup>&</sup>lt;sup>1</sup> The development of ICT is regarded as a 'second unbundling of globalization', resulting in a significant transformation of the global paradigm of international trade. For detail understanding of the gradual evolution from a pre-globalized world to today's modern developed world Baldwin's book "*The Great Convergence*" (2015) is referred.

Figure 1 displays the rising trend of service sector exports for some developed (dotted lines) and developing (solid lines) nations from 2000-2017.

In overall services, developed economies such as the United States and the United Kingdom emerge as predominant exporters. Conversely, in ICT services—which represent the most virtual mode of service delivery—India's export volume surpasses that of both the USA and UK. For imports, barring China, the principal service importers are exclusively developed nations (as evidenced in Figure 2).



Source: World Bank

Figure 2 displays the rising trend of service sector imports for some developed (dotted lines) and developing (solid lines) nations from 2000-2017.

This empirical data suggests a noticeable trend - developing countries leverage their comparative advantage in labour costs to augment their participation in the global service trade arena. The observed patterns underscore the evolving dynamics of international service trade and the increasing role of developing economies in specific service sectors.



Source: World Bank

Figure 3 displays the rising trend of ICT-enabled service sector exports for some developed (dotted lines) and developing (solid lines) nations from 2000-2017.



Source: World Bank

*Figure 4 displays the rising trend of ICT-enabled service sector imports for some developed (dotted lines) and developing (solid lines) nations from 2000-2017.* 

The convergence of digital technologies, standardized processes, and the globalized nature of service delivery collectively contribute to lessening the adverse impact of geographical distance, particularly in service trade, with a notable emphasis on ICT-enabled services. Contemporary literature propounds that increased geographical distance inherently implies time zone difference between nations, and can potentially serve as a source of comparative advantage, especially within the domain of ICT-enabled services (Marjit, 2007; Kikuchi, 2009,

2011; Head et al., 2009; Marjit and Mandal, 2020). Head et al. (2008) and Kikuchi (2011) have identified two effects to elucidate the impact of time zone differences:

(a) Continuity Effect (CE): Non-overlapping time zones facilitate the implementation of continuous workflow processes across global boundaries, enabling the timely delivery of services (Marjit et al., 2020).

(b) Synchronization Effect (SE): Increased geographical distances often correspond with cultural disparities, potentially impeding synchronization efforts.

Within this contextual framework, the present study investigates the influence of time zone differences on service trade through the CE and SE, along with other determinants, for a sample of bilateral pairs of 162 countries for 2018. Furthermore, this research seeks to address *whether and how*, if at all, there is any variation in the impact of time zone differences across various categories of service trade. For this purpose, we have considered two contrasting categories – one is modern ICT-enabled services and the other one is traditional travel-transport services. Delving further deep, we examine is it possible to identify the optimal time zone differentials between country pairs that may maximize the benefits derived from the CE. Finally, we analyse the nature of the countries located in the optimum time zone gap and their trade patterns. These findings hold significant implications for nations engaged in establishing bilateral trade relationships. This research contributes to the existing literature by providing empirical evidence on the complex interplay between time zone differences and service trade, offering insights that may inform international trade policies and strategies, especially in establishing bilateral trade relations.

This study contributes to the extant literature in several significant ways. It is a comprehensive analysis of time zone effects. We extend the existing research by examining the impact of time zone differentials on overall services trade, as well as two contrasting categories: modern ICT-enabled services and traditional travel and transportation services. While previous studies such as Dettmer (2014) and Tomasik (2013) have investigated these effects within limited contexts, our research encompasses a substantially larger dataset of 162 WTO member countries, providing a more comprehensive global perspective.

Secondly, a novel aspect of our study is the identification of optimal time zone difference ranges that maximize the benefits of CE. We determine unique ranges for three distinct service categories, providing crucial insights for maximizing comparative advantage and enabling partner countries to effectively leverage a 24-hour work cycle. Furthermore, we explore the

economic development characteristics of country pairs within these optimal ranges, yielding valuable insights.

Thirdly, our research employs various alternative measures to capture the SE, diverging from existing literature. We incorporate socio-economic indicators such as government effectiveness, political stability and absence of violence/terrorism. Additionally, we utilize the Intellectual Property Rights (IPR) index as a proxy for SE, recognizing the crucial role of IPR in fostering innovation, enhancing market position, and providing legal protection in service-oriented businesses.

Fourth, we consider bilateral trade determinants at a more nuanced level. While standard literature emphasizes common language among trading partners (Melitz & Toubal, 2014), we incorporate human capital with language proximity, acknowledging the significance of workers' communication skills in service delivery. Moreover, we employ service value added in GDP per capita as a proxy for service sector capital stock, recognizing that service expansion depends on sector-specific capital such as information and communication technology infrastructure. We also consider the difference in service sector value added in GDP per capita to capture how sectoral endowment disparities between countries influence service trade.

The Poisson-pseudo maximum likelihood (PPML) estimation yields results indicating the presence of CE across all service categories examined. Conversely, the SE demonstrates statistical significance exclusively for ICT-enabled services. Our analysis reveals that ICT plays a pivotal role in facilitating bilateral trade expansion, alongside other significant factors such as linguistic proximity of the workforce and robust IPR regimes in the trading partner countries. A notable finding pertains to the variation in the effective time window for CE across service categories. ICT-enabled services exhibit the narrowest optimal time difference range (8-10 hours), whereas travel-transport services and aggregate services demonstrate considerably broader ranges (7-15 hours).

Further examination of country pairs within the optimal time zone ranges reveals an intriguing pattern across all three service categories South-South pairs constitute the largest proportion (70%), followed by North-South pairs (30%) and North-North pairs (less than 5%). These findings suggest that developing countries are well-positioned to capitalize on service trade opportunities by leveraging their geographical locations within non-overlapping time zones. However, to fully realize these benefits, countries must also meet other requisite conditions, including advanced ICT infrastructure, appropriate human capital development, and stringent

IPR regimes. This research provides empirical evidence supporting the strategic importance of time zone differences in international service trade and offers valuable insights for policymakers and trade strategists in developing countries seeking to enhance their participation in the global service economy.

The present paper is arranged as follows. Section 2 frames out the analytical structure of our study and specifies the model. In section 3 we discuss the methodology. Section 4 presents the estimation results. In Section 5 we identify the optimum time zone difference for each category of services for the effectiveness of CE. Finally, section 6 concludes the paper.

### 2. Analytical Framework and Model Specification

### 2.1. Analytical Framework

The standard gravity model of international trade posits that bilateral trade flows are inversely proportional to the geographic distance between two nations and directly proportional to their respective economic magnitudes, typically quantified by market size.

$$T_{ij} = A \frac{Y_i Y_j}{D_{ij}} \quad \dots \quad (A)$$

Here,  $T_{ij}$  is the value of bilateral trade flow among the country pairs. A is a constant,  $Y_i$  and  $Y_j$  are the income levels of countries i and j respectively and  $D_{ij}$  is the distance between country pairs.

The seminal gravity model of international trade, originally formulated by Tinbergen (1962), has seen substantial enhancements in recent decades. Contemporary research has expanded the model's explanatory power by incorporating additional variables hypothesized to influence bilateral trade flows like Anderson and van Wincoop (2003). Authors expanded the standard gravity model including exporter and importer fixed effects as following

$$T_{ij} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{ij}^{\alpha_3} e^{\theta_i d_i + \theta_j d_j} \dots (B)$$

Where  $d_i$  and  $d_j$  are dummies identifying the exporter and importer, the rest of the variables are similar to equation (A). It introduced multilateral resistance terms to account for the broader context of a country's trade relationships within the global economic system.

In the present study, we examine the effect of time zone difference along with other standard gravity model variables of service trade following Kimura and Lee (2006).

In this paper, we use the absolute time difference between countries as a proxy for geographical distance, based on the observation that time disparities increase with latitudinal distance. Since the relative time of day between two nations is potentially more important than the total time zone difference, we consider<sup>2</sup>. The absolute time zone difference between the capitals of the country pair is measured in minutes. The time zone difference is calculated according to Coordinated Universal Time (UTC).

Following Marjit et al., (2020) we incorporate the two effects of time zone difference in a gravity model-like framework.

a) Continuity Effect:

To account for the potential benefits of continuity effect, we introduce a dummy variable that captures significant time zone differentials between trading partners. This approach is grounded in the theoretical framework proposed by Marjit et al. (2020). Empirical findings of Dettmer (2014) suggest that substantial time zone differences can facilitate a continuous workflow in service sector through strategic transfer or outsourcing globally. To capture the continuous workflow between countries located in non-overlapping time regions, we have defined the dummy variable  $D_8$  which takes value 1 for countries with time zone differences of 8 hours or more, and 0 otherwise.

# $D_8 = \begin{cases} 1 \text{ if the time zone difference is more than or equal to 8 hours} \\ 0 \text{ otherwise} \end{cases}$

As the working hours in one country end, the working hours of its partner country begin, implying an 8-hour time difference between the pair. We have considered 8-hour difference as this is the standard working hour as per ILO Convention (1930). This variable tests whether non-overlapping work schedules between countries benefit industries suited to fragmentation and virtual collaboration.

### b) Synchronization Effect

This study introduces novel measures to assess institutional and cultural synchronization between trading partners in service trade. Moving beyond traditional indicators like colonial

 $<sup>^{2}</sup>$  For countries with multiple time zones, we have taken the time zone of the capital city and there is no adjustment for daylight savings time for consistency.

ties and trade agreements, it incorporates variables such as Intellectual Property Rights protection, World Governance Indicators like government effectiveness, political stability and absence of violence. The research uses the difference between reporter and partner countries for each measure. This elucidates how disparities in socio-economic conditions between nations influence the decision-making processes governing export activities and partner selection.<sup>3</sup>

The variable government effectiveness (GOV) quantifies the efficacy and transparency of a nation's bureaucratic apparatus, while political stability (POL) measures the perceived levels of terrorism and political volatility within a given state. These variables serve as proxies for how a reporting country might select its trading partners from among nations sharing similar temporal and cultural characteristics. For example, India and Pakistan exhibit comparable cultural backgrounds and occupy analogous time zones relative to the United States, despite India demonstrating superior governance metrics (with values of 0.295 and -0.631, respectively, in 2018). Consequently, when the United States evaluates potential trade partners, it would likely favour India. An equivalent rationale applies to the political stability variable.

Intellectual Property Rights (IPR) indicators are widely recognized as metrics of a nation's institutional quality. Helpman (1992) and Iwaisako (2013) have extensively elucidated the role of IPR in fostering innovation. This study examines the role of IPR in international trade, focusing on its impact on the service sector. IPR indicators are crucial for innovation in sectors like software development and financial services. So far there is very limited application of IPR in the context of trade. We explore the non-linear relationship between trade flows and IPR, influenced by economic development and sectoral involvement. The service sector, being intellectual property-intensive, particularly benefits from strong IPR protections for ICT-enabled and financial services. Our analysis employs the Intellectual Property Rights Index, a component of the International Property Rights Index (IPRI) from the Property Rights Alliance. This index averages three elements: protection of intellectual property rights, copyright piracy, and patent protection. We consider the difference of IPR indicator values between reporter and

<sup>&</sup>lt;sup>3</sup> The WGI data are gathered from over 30 diverse sources, including international organizations, nongovernmental organizations, and private firms worldwide. These data sources are then rescaled and combined to produce six aggregate indicators using a statistical methodology called the Unobserved Components Model (UCM).

partner country to capture the variation of IPR law.<sup>4</sup> In particular, we take the difference in the IPR index between two countries as two distinct variables: IPRp = positive difference between IPR values and, IPRn = negative differences between IPR values.

### 2.2.Model Specification

Our empirical investigation begins with the estimation of the standard gravity model represented by equation (1):

$$Trade\_Flow_{ij} = \alpha_0 + \alpha_1 \ln(GDP_{Partner}) + \alpha_2 \ln(GDP_{Reporter}) + \alpha_3 Time \ difference_{ij} + \varepsilon_{ij} - \cdots (1)$$

This study employs bilateral trade flow as the dependent variable in its empirical model, encompassing aggregate service sector, ICT-enabled services, and travel and transportation. This approach, aligned with Kimura and Lee (2006), provides a comprehensive view of economic interdependence between country pairs. It contrasts with previous research by Grünfeld and Moxnes (2003), Walsh (2006), and Tomasik (2013), which analysed exports and imports separately. This approach enhances the model's ability to assess the complex nature of bilateral economic relationships in the context of international trade.

Next, we aim to capture the presence and extent of the CE and  $SE^5$  as determinants of bilateral trade flow in a standard gravity model framework considering other determinants like respective economies' market sizes, and time zone differences. So, the benchmark model in equation (2) is:

 $Trade\_Flow_{ij} = \alpha_0 + \alpha_1 \ln (GDP_{Partner}) + \alpha_2 \ln (GDP_{Reporter}) + \alpha_3 Time \ difference_{ij} + \alpha_4 Time \ Dummy_{ij} + \alpha_5 \ GOV_{ij} + \alpha_6 \ POL_{ij} + \alpha_7 IPR_{ij} + \varepsilon_{ij} \quad ----$ (2)

Going further, we augment the model with other determinants of service trade like physical and human capital and differences in endowment like the augmented gravity model equation.

<sup>&</sup>lt;sup>4</sup> This index is calculated based on the data collected for 10 different indicators for 2000-2017 and rescaling them.

<sup>&</sup>lt;sup>5</sup> The model (2) is estimated using different measures of SE such as RTA dummy, sibling relation, and colonial ties. The best indicators for this analysis are identified to be the IPR indicator, Government effectiveness, and Political stability of the country.

Unlike the standard gravity model, we have incorporated indicators of ICT technology. Hence, we have the following augmented model in equation (3):

 $Trade_Flow_{ij} = \beta_0 + \beta_1 \ln (GDP_{Partner}) + \beta_2 \ln (GDP_{Reporter}) + \beta_3 Time \ difference_{ij} + \beta_4 Time \ Dummy_{ij} + \beta_5 \ GOV_{ij} + \beta_6 POL_{ij} + \beta_7 \ IPR_{ij} + \beta_8 \ ICT_{ij} + \beta_9 \ GFCF_{ij} + \beta_{10} \ FDI_{ij} + \beta_{11} \ SerVA_{PC_{ij}} + \beta_{12} \ HC_{ij} + \varepsilon_{ij} \ ---- \ (3)$ 

Equation (3) encapsulates the influence of the fourth dimension of trade—namely, time zonerelated variables and socio-economic variables—on bilateral trade flows while controlling for other established determinants of trade. Note that, for all bilateral explanatory variables, apart from SE measures, the average value of the indicators for ij-th country pair has been considered.

Our main variables of interest, the measures of continuity and synchronization effect, have already been discussed in the previous section (refer to section 2(b)).

The study incorporates GDP of both partner and reporter countries as key determinants of bilateral trade, following Dettmer (2014) and Kimura and Lee (2006). GDP serves as a proxy for market size, reflecting aggregate demand and potential service trade volume. This economic indicator is crucial in assessing countries' capacity for international trade engagement.

This study enhances the gravity model framework by incorporating service sector-specific endowment differentials, extending beyond traditional approaches that use per capita GDP differences to reflect capital-labour endowments in the Heckscher-Ohlin-Samuelson model. The research measures these differentials as the gap in GDP per capita value added by the service sector between trading partners. This refinement accounts for the unique capital and labour requirements of the service sector, including financial capital, ICT infrastructure, and specialized skills. The approach also considers the significant contribution of producer services to value-added in traded goods, particularly in high-income countries where services comprise approximately 70% of value added (Francois et al., 2013).

ICT infrastructure is widely recognized as a critical prerequisite for service trade (Freund and Weinhold,2002; Choi 2010). Technologies such as mobile networks, internet connectivity, and satellite systems play a pivotal role in generating comparative advantages in the global marketplace (Marjit, 2007). Consequently, our model incorporates two key indicators of ICT infrastructure: mobile and broadband connections.

Furthermore, our analysis considers two distinct forms of capital: physical and human. To evaluate the impact of physical capital, we include gross fixed capital formation (GFCF) as a measure of domestic physical capital accumulation, and foreign direct investment (FDI) to capture the influence of international capital flows.

Services are characteristically labour-intensive, particularly in developing economies. Eichengreen and Gupta (2012) and Sahoo et al. (2013) underscore the critical role of human capital in the service sector. Moreover, extant literature emphasizes the significance of common language in mitigating transaction costs among partners. Using a common language facilitates mutual comprehension and trust (Burchell and Wilkinson, 1997). In light of these, our study incorporates a measure of common language-speaking human capital, quantified by the average mean years of schooling. Furthermore, we employ an interaction term between the human capital measure and a common language indicator. We utilize the Common Language Index developed by Melitz and Toubal (2014) to operationalize the common language variable. This index is constructed based on three dimensions of linguistic commonality between country pairs: shared official language, common native language, and linguistic proximity.

The present study considers 162 out of the 164 WTO member countries, based on data availability. It is noteworthy that our analytical framework employs bilateral country pairs, denoted as i and j, without assigning a specific reporter or partner. This methodological approach precludes the redundant inclusion of reciprocal pairs (i.e., we consider i-j bilateral pairs exclusively, omitting j-i configurations). Consequently, our dataset comprises a total of 13,041 unique country pairs for each category of services under examination.

### 3. Methodology

The estimation of the multiplicative gravity model via ordinary least squares (OLS) requires a logarithmic transformation of both the dependent and independent variables. Extant literature posits that OLS estimation of such an equation yields inconsistent estimates if the error term is also log transformed. Furthermore, it is crucial to note that the dependent variable in the log-transformed gravity model represents bilateral trade between two country pairs. Consequently, the dependent variable becomes undefined when bilateral trade is absent between two

countries. This scenario leads to exclusion of such country pairs from the OLS estimation, potentially introducing bias due to the loss of pertinent information.<sup>6</sup>

Given these considerations, the Poisson Pseudo Maximum Likelihood (PPML) estimation method emerges as a more suitable technique for estimating the multiplicative form of the gravity equation. While Poisson estimation is frequently employed for count data, it is important to note that export data does not strictly adhere to a Poisson distribution. Therefore, we call it a Pseudo Poisson Maximum Likelihood model. The PPML estimation method yields consistent estimates of the conditional population mean of the dependent variable, the bilateral trade. Moreover, even to potentially enhance efficiency, one may employ a pseudo-maximumlikelihood estimator, as suggested by Motta (2019).

Silva and Tenreyro (2006) on the other hand demonstrate that the PPML estimator produces consistent estimates under minimal assumptions. They argue that PPML offers several advantages over alternative approaches, notably its ability to incorporate zero or missing trade values, which are prevalent in trade matrices, rather than omitting them. In the PPML framework, the dependent variable—trade values—is incorporated in levels rather than logarithmic form within the gravity model. Given the econometric issues at hand and the presence of missing values and sub-unity trade figures in the dataset, PPML emerges as the most appropriate methodological approach for this analysis.<sup>7</sup> As a result, various empirical papers like Tomasik (2013), Majune et al. (2023), and Maghssudipour et al. (2022) have already used PPML estimation, which exemplify the growing adoption and recognition of PPML as a robust estimation technique in empirical trade research.

<sup>&</sup>lt;sup>6</sup> In our analysis, we initially applied OLS to the log-linear model for three service categories. The Breusch-Pagan test confirmed heteroscedasticity in all categories. Silva and Tenreyro (2006) demonstrated that OLS yields biased results under heteroscedasticity in gravity models. Consequently, we adopted the PPML method, which provides consistent estimates in the presence of heteroscedasticity.

We also employed the Heckman Two-step Sample Selection Estimator. However, while applicable to ICTenabled services with zero trade values in 2018, it proved unsuitable for the aggregate category lacking zero values. Given this limitation, we opted to proceed with the PPML estimation method for all categories.

<sup>&</sup>lt;sup>7</sup> For the detailed methodology please refer to Appendix A.2. also see, Gourieroux, Monfort, & Trognon (1984) for a detailed discussion of various types of PPML models.

### 4. Estimation Results

Tables 1, 2, and 3 present the PPML estimation results for aggregate services and two disaggregate-level services – ICT-enabled services and travel-transportation services. Panel A of each table shows the basic gravity model estimation of equation (1), Panel B represents our benchmark model – equation (2) – which captures how much of the bilateral trade flow between two countries is influenced through continuity and synchronization effects apart from the basic gravity model variables. Next, panel C exhibits the augmented model represented by equation (3) considering two different measures of human capital and other determinants of trade.

The empirical analysis demonstrates that time differences between nations have a statistically significant negative effect on service trade across all categories examined (as evidenced in row 1 of Tables 1, 2, and 3). Empirical results suggest that 0.1 change in time difference will lead to a fall in trade by 0.03% between the country pairs. This finding aligns with the predictions of the standard gravity model, which posits an inverse relationship between trade volume and increased time difference. These results corroborate the conclusions drawn by Tomasik (2013) and Egger and Larch (2013) in their respective studies.

The focal variables in our analysis are the measures of CE and SE. The statistically significant positive coefficient of the  $D_8$  variable substantiates the presence of CE across all service categories examined (refer to 4th row of Tables 1, 2, and 3). Marjit et al. (2020) propound that CE facilitates the disaggregation of workflow, enabling more efficient completion through outsourcing to non-overlapping time zones. The inherent advantage of service trade lies in its seamless transmission capabilities, allowing counterpart countries to complete tasks overnight and relay them back to the source country by the following morning (Marjit et al., 2020).

Certain service sectors, such as financial and business services, now operate on a global, 24hour basis, effectively eliminating fixed hours of availability.<sup>8</sup> Moreover, various consultation services frequently occur between countries situated across different continents. Consequently, time differences catalyse service expansion. Tomasik (2013) and Dettmer (2014) also demonstrated that services can benefit from time differences among trading partners.

The CE significantly benefits disaggregate-level services as well. Countries like the US and those in Europe outsource skilled programming jobs to regions with lower labour costs,

<sup>&</sup>lt;sup>8</sup> According to Nakanishi and Van Long (2015) when two identical countries, located in opposite time zones, engage in free trade, the labour force in both countries works exclusively during their respective daytime hours. Consequently, the night shift in each country is outsourced to the other, where it coincides with local daytime.

leveraging time differences for overnight task completion (Bardhan, 2004, 2006; Marjit et al., 2020). In travel services, tourists often prefer visiting distant countries with substantial time differences to experience diverse cultures and lifestyles. McKercher & du Cros (2003) note that many long-haul travellers seek cultural enrichment and knowledge enhancement. Also, time disparities facilitate efficient business processes and enriched cultural experiences in tourism.

	Bilateral Flow of Aggregate Services Trade						
	А	В	C			D	
Variables	(1)	(1.1)	(1.2)	(1.3)	(1.2.1)	(1.2.2)	(1.2.3)
Time_Diff	-0.003***	-0.003***	-0.003***	-0.003***	-0.002***	-0.003***	-0.003***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ln(GDP <sub>Reporter</sub> )	0.76***	0.73***	0.69***	0.71***	0.69***	0.69***	0.69***
	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
In(GDP <sub>Partner</sub> )	0.83***	0.83***	0.70***	0.72***	0.70***	0.69***	0.69***
_	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
$D_8$		0.62***	0.57***	0.43***			
IDD		(0.15)	(0.14)	(0.15)	0.00***	0.20***	0.01***
пък_р		-0.36***	-0.20***	-0.35***	-0.20***	-0.20***	-0.21***
IDD		(0.08)	(0.05)	(0.07)	(0.05)	(0.05)	(0.05)
IPK_n		0.3/***	0.16***	0.28***	0.16***	0.14***	0.15***
CE D		(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)
GE_D		0.22*	0.11	0.10	0.11	0.12	0.11
DOL D		(0.13)	(0.10)	(0.12)	(0.10)	(0.10)	(0.10)
POL_D		-0.15**	0.05	0.08	0.05	0.03	0.05
		(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.08)
Mobile			0.01***	0.01**	0.01***	0.01***	0.01***
Tatana			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Internet			0.05***	0.05***	0.05***	0.05***	0.05***
OFOF			(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
GrCr			0.01	-0.01	0.01	0.01	0.01
EDI			(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI			0.001	0.01	0.003	0.002	0.002
Courses VA			(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Service_vA <sub>PC</sub>			0.12***	0.18***	0.11**	0.11**	0.11***
IIC#I			(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
HC*Lang			0.14***		0.14***	0.14***	0.14***
110			(0.02)	0.04	(0.02)	(0.02)	(0.02)
нс				0.04			
				(0.04)	0.04		
$\mathbf{D}_7$					0.24**		
					(0.12)		
•							
D						0.92**	
$D_{14}$						(0.32)	
D.,						(0.32)	0.09
<b>D</b> 15							-0.09
Constant	-74 35***	-23 10***	-74 30***	-74 90***	-74 77***	-74 13***	-24 18***
Constant	(0.83)	(0.82)	(1.05)	(1.40)	(1.07)	(0.98)	(1.06)
Observations	12.880	6 670	(1.05)	(1.40)	(1.07)	(0.20)	(1.00)
nsaudo- <b>P</b> -servered	12,000	0,070	4,045	4,930	4,045	4,045	4,045
pseudo- <b>k</b> -squared	0.30	0.39	0./5	0.07	0.74	0.70	0.74

### **Table 1. Estimation Results for Aggregate Services**

Note: Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Findings reveal that SE indicator, government effectiveness positively impacts overall services trade for cross-border business and contractual negotiations (Panel B, row 7, Table 1). For ICT-enabled services, which are primarily virtual and traded remotely, government effectiveness is

significant in the augmented model (Panels B and C, Table 2), highlighting the importance of effective governance in this sector. The estimation results indicate that a 0.1-unit increase in the GOV variable is associated with a 2.2% increase in trade between countries for aggregate services.

However, government effectiveness shows no significant impact on travel and transportation services (Panel B, Table 3). This varied influence of government effectiveness across service categories emphasizes the heterogeneous nature of service trade and the differing importance of institutional quality among sectors. The findings underscore the need for tailored policy approaches to enhance service trade across different categories.

Our analysis reveals that government effectiveness positively impacts overall services trade for cross-border business and contractual negotiations (Panel B, row 7, Table 1). For ICT-enabled services, which are primarily virtual and traded remotely, government effectiveness is significant in the augmented model (Panels B and C, Table 2), highlighting the importance of effective governance in this sector. However, government effectiveness shows no significant impact on travel and transportation services (Panel B, Table 3). For this specific service category, the estimation results indicate that a 0.1-unit increase in the GOV variable is associated with a 2.6% rise in bilateral trade. This varied influence of government effectiveness across service categories emphasizes the heterogeneous nature of service trade and the differing importance of institutional quality among sectors. The findings underscore the need for tailored policy approaches to enhance service trade across different categories.

Upon extending the model to incorporate additional determinants of service trade, including human capital, physical capital, and ICT indicators (as delineated in Panel C of Tables 1, 2, and 3), SE loses statistical significance for aggregate services and the travel and transportation category (refer to Panel C of Tables 1 and 3). However, the CE maintains its statistical significance across these specifications. This phenomenon suggests that enhanced infrastructure and state-of-the-art connectivity technologies may enable service providers to mitigate socio-economic challenges effectively. In the context of ICT-enabled services, the government effectiveness index retains its statistical significance, underscoring its crucial role

in facilitating the efficient operation of virtual service trade (as evidenced in Panel C of Table 2).

	Bilateral Flow of ICT-enabled Service Trade						
	А	В		С		D	
Variables	(2)	(2.1)	(2.2)	(2.3)	(2.2.1)	(2.2.2)	(2.2.3)
Time_Diff	-0.003***	-0.004***	-0.003***	-0.003***	-0.003***	-0.003***	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
In (GDP <sub>Penarter</sub> )	0.75***	0.70***	0.60***	0.63***	0.60***	0.60***	0.60***
( ) = - Reporter	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
ln (GDP <sub>Partner</sub> )	0.82***	0.81***	0.64***	0.64***	0.64***	0.63***	0.63***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
$D_8$		0.76***	0.75***	0.60**			
		(0.24)	(0.29)	(0.28)			
IPR_p		-0.47***	-0.38***	-0.52***	-0.38***	-0.39***	-0.39***
		(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)
IPR_n		0.44***	0.32***	0.40***	0.32***	0.32***	0.31***
		(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Gov_Eff		0.30**	0.26*	0.30**	0.25*	0.23*	0.25*
		(0.14)	(0.15)	(0.15)	(0.14)	(0.14)	(0.15)
POL		-0.13	-0.02	-0.01	-0.02	-0.03	-0.02
		(0.08)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Mobile			-0.002	-0.01	-0.002	-0.002	-0.002
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Internet			0.05***	0.03***	0.05***	0.05***	0.05***
			(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
GFCF			0.02*	0.02	0.02	0.02	0.02*
			(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI			0.02	0.02*	0.02	0.02*	0.02
			(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Service_VA <sub>PC</sub>			0.22***	0.24***	0.20***	0.22***	0.21***
			(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
HC*Lang			0.12***		0.12***	0.11***	0.12***
			(0.02)		(0.02)	(0.02)	(0.02)
НС				0.17***			
				(0.04)			
$\mathbf{D}_7$					0.30		
					(0.20)		
•							
D						1 20***	
$D_{10}$						(0.46)	
D11						(0110)	0.34
							(0.39)
Constant	-26.40***	-24.33***	-23.16***	-24.38***	-22.98***	-23.01***	-22.91***
	(0.97)	(1.01)	(1.33)	(1.41)	(1.31)	(1.21)	(1.28)
Observations	12.880	6,670	4,845	4,950	4,845	4,845	4,845
pseudo-R-squared	0.34	0.43	0.51	0.47	0.50	0.53	0.51

**Table 2. Estimation Results for ICT-enabled Services** 

Note: Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Our analysis of IPR's impact on international service trade reveals significant correlations. *IPRp* (partner country's IPR) shows a negative correlation, while *IPRn* (reporter country's IPR)

demonstrates a positive correlation for aggregate and ICT-enabled services across all model specifications (Panels B and C, Tables 1 and 2).

This suggests that reporter countries benefit from less stringent IP legislation in partner countries, likely due to streamlined processes and reduced legal barriers<sup>9</sup>. A lenient IPR regime may lower license acquisition and procedural costs, creating a cost-effective environment for service providers and facilitating favourable trade patterns for reporting countries. Notably, IPR shows no significant effect on travel and transportation services (Panel C, Table 3). These findings highlight the complex interplay between IPR regimes and international service trade.

Market size, measured by GDP, shows a highly significant positive correlation with all types of service trade flows, aligning with Dettmer's (2014) findings. No home market effect is observed in bilateral service flows across categories, consistent with Grünfeld and Moxnes (2003), as GDP coefficients are similar for partners and reporters.

Analysis of communication technology's impact on service trade reveals sector-specific patterns. Internet and mobile connectivity are crucial for aggregate and travel-transport services, but mobile connectivity has no impact on ICT services, where broadband is significantly important. Interpersonal connectivity is vital for sectors like construction, insurance, and finance. Improved communication networks enhance cross-border business service flows, with ICT-enabled services relying on advanced technologies such as broadband. These findings, aligning with Dettmer's (2014) observations, underscore the need for sector-specific policies in service trade.

Panel C of our results employs alternative human capital measures to estimate an augmented model, revealing that models incorporating language-interacted human capital have a superior fit compared to those using simple human capital measures (see models 1.2 to 1.3, 2.2 to 2.3, and 3.2 to 3.3). Human capital alone shows no statistically significant impact on aggregate services or travel and transportation sectors (models 1.3 and 3.3). From the analysis, we can see that 0.1 increase in human capital with linguistic proximity indicator leads to a 1.4% and 1.3% increase in aggregate service trade and travel transportation services respectively, whereas for ICT-enabled services the rise is 1.2%. This suggests that linguistic proximity is more significant than human capital endowment. These findings align with Park (2002) and Walsh (2006), who emphasized the importance of common language in service trade, as

<sup>&</sup>lt;sup>9</sup> "How Does Intellectual Property Affect International Trade? by Arlen Olsen, April 03, 2023 *https://iplawusa.com/how-does-intellectual-property-affect-international-trade/* 

linguistic similarity enhances skill transfer, communication efficacy, and trust (Burchell & Wilkinson, 1997).

	Bilateral Trade Flow of Travel and Transportation Services						
	А	В	(	C		D	
Variables	(3)	(3.1)	(3.2)	(3.3)	(3.2.1)	(3.2.2)	(3.2.3)
Time_Diff	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.002***	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
In (GDP <sub>Reporter</sub> )	0.76***	0.74***	0.69***	0.70***	0.69***	0.69***	0.69***
	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
In (GDP <sub>Partner</sub> )	0.76***	0.76***	0.69***	0.71***	0.69***	0.68***	0.68***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
$D_8$		0.74***	0.70***	0.64***			
		(0.12)	(0.12)	(0.12)			
IPR_p		-0.18**	-0.03	-0.15**	-0.04	-0.05	-0.04
		(0.09)	(0.04)	(0.06)	(0.05)	(0.05)	(0.05)
IPR_n		0.18***	0.02	0.12**	0.02	0.02	0.02
		(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Gov_Eff		0.20	0.09	0.07	0.09	0.10	0.10
		(0.14)	(0.08)	(0.10)	(0.08)	(0.09)	(0.09)
POL		-0.23***	-0.06	-0.03	-0.07	-0.07	-0.07
		(0.05)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)
Mobile			0.01***	0.01***	0.01***	0.01***	0.01***
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Internet			0.04***	0.05***	0.04***	0.04***	0.04***
			(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
GFCF			0.02**	-0.001	0.02**	0.02**	0.02**
			(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI			0.02***	0.02***	0.02***	0.02***	0.02***
			(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Service_VA <sub>PC</sub>			0.07*	0.13***	0.05	0.06	0.05
			(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
HC*Lang			0.13***		0.13***	0.12***	0.12***
			(0.02)		(0.02)	(0.02)	(0.02)
HC				-0.05			
				(0.04)			
$\mathbf{D}_7$					0.31***		
					(0.11)		
•							
D						0.50**	
<b>D</b> <sub>15</sub>						0.59**	
D.,						(0.2))	0.24
D <sub>16</sub>							(0.30)
Constant	73 68***	22 86***	-24 50***	71 77***	24 41***	24 20***	24 25***
Constant	-23.00****	-22.00	-24.30****	-24.27****	-24.41	-24.39***	$-24.33^{+++}$
Observations	12 000	(0.04)	(1.01)	(1.31)	(1.03)	(1.07)	(1.07)
observations	12,880	0,070	4,045	4,900	4,045	4,645	4,845
pseudo- <b>k</b> -squarea	0.52	0.55	0.72	0.04	0.09	0.09	0.09

 Table 3. Estimation Results for Travel and Transportation Services

Note: Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

We analyse the importance of GFCF and FDI in service sector. The service sector's virtual nature reduces reliance on physical capital, with the GFCF variable showing statistical

insignificance across service categories. In contrast, foreign direct investment (FDI) has a statistically significant positive impact on the travel and transportation sector.

The travel and tourism industry provides significant economic development opportunities globally. Developed nations like the US and European countries, as well as emerging economies such as Singapore, UAE, Malaysia, and Mauritius, benefit from substantial foreign capital inflows, highlighting the sector's importance for both established and developing destinations. This capital infusion enhances productivity and sustainability in tourism and the broader economy, generating positive spillovers to other sectors (UNCTAD, 2007).

Additionally, the global expansion of multinational corporations (MNCs) significantly boosts tourism and transportation. International hotel chains, such as Marriott and Hilton, invest heavily in luxury resorts, while theme park operators like Disney and Universal Studios expand internationally, establishing major tourist attractions across various countries.

 Table 4: Comparison of Existence of Continuity effect and Synchronization effect across

 Categories of Services

Service Categories	CE	SE		
		IPR	GOV EFF	POL
Aggregate Services	$\checkmark$	$\checkmark$	_	_
<b>ICT-enabled Services</b>	$\checkmark$	$\checkmark$	$\checkmark$	_
<b>Travel – Transportation Services</b>	$\checkmark$	_	_	_

Source: based on own calculation

A highly significant positive correlation exists between differences in value-added services per capita and total trade flow, indicating that countries with greater endowment disparities engage more in trade (Parakh and Aditya, 2021). Nations with limited sector-specific capital often import services to fulfil domestic needs, while developed economies outsource tasks to lower-cost labour countries to enhance production efficiency and reduce costs. Additionally, endowment differences between countries in non-overlapping time zones support round-the-clock service provision, improving global service delivery efficiency.

Our empirical analysis reveals that CE is present across all service categories, though sectorspecific variations in SE are observed. Enhanced domestic infrastructure mitigates negative SE in aggregate and travel/transport services, while governance transparency and bureaucratic efficiency positively influence ICT-enabled services. Broadband connectivity is crucial for all service types, whereas mobile connectivity affects only aggregate and travel/transport sectors. Linguistic proximity and human capital have varying impacts across sectors. These findings enrich our understanding of international trade dynamics, offering nuanced insights into service trade determinants and aligning with existing literature.

### 5. Determination of Optimum Time Zone Difference

In this section, we relax the previously imposed constraint of an 8-hour time difference between country pairs. Empirical evidence suggests that nations with varying time disparities also engage in service trade. Christen (2017) identified a natural threshold for time differences between the United States and its trading partners via affiliates. We aim to identify a range of non-overlapping time differences that facilitate international trade while maximizing the benefits of the CE.

To determine the optimum time window, we redefine the time difference dummy by varying the time gap by  $8\pm n$  hours, where n = 1, 2, ... up to 8. This generates new time dummies D<sub>7</sub>, D<sub>9</sub>, D<sub>10</sub>, and so forth, with the subscript denoting the specific time difference.

Subsequently, we estimated models 1.2, 2.2, and 3.2 with the new time dummies, ranging from  $D_6$  to  $D_{16}$  in alternate specifications. The estimation result is reported in Panel D of Tables 1, 2, and 3.<sup>10</sup> The primary objective of these estimations is to identify the ranges of time dummies for which the CE exhibits a statistically significant positive impact on service trade. Notably, our analysis reveals that for the three distinct categories of services examined, we have identified three different optimal time difference windows<sup>11</sup> in which CE demonstrates instrumental efficacy (refer to Table 5).

 $<sup>^{10}</sup>$  For each category of services, we have re-estimated models 1.2, 2.2., and 3.2 using dummy variables D<sub>7</sub> and onwards. Our objective is to identify the range within which the variable of interest maintains positive statistical significance. Our analysis reveals distinct ranges of time differences for the three service categories under examination.

<sup>&</sup>lt;sup>11</sup> For all three service categories, equation 3 is estimated across a range of time dummies. This approach is designed to assess the consistency of the SE for country pairs across various time windows. Our findings indicate that the impact of the SE variables remains consistent with the originally estimated augmented model structures. Moreover, the nature of other determinants of service trade across different categories exhibits stability. Although there is a marginal variation in the pseudo-R-squared- the overall results remain consistent, suggesting robustness in our findings. This consistency across various time windows and model specifications provides strong support for the validity of our initial conclusions regarding the determinants of service trade.

In the case of ICT-enabled services - the most virtual form of services - we observe the narrowest time window for effective trade. Conversely, when considering aggregate services, the range of optimal time differences is substantially broader. Christen (2017) identified three natural thresholds for time differences between the United States and its partner countries in foreign affiliate sales: 5-6 hours, 9-10.5 hours, and 11-12 hours. The United States frequently opts to deliver services via foreign affiliates to countries within these time differences to mitigate the high costs associated with direct exports.

Service Categories	<b>Optimum Time Difference</b>	North-South pair	South-South pair
Services Overall	7-14 hrs	30%	66%
ICT-enables services	8-10 hrs	27.3%	68%
Travel and Transportation Services	7-15 hrs	30%	66%

Table 5: Optimum No Overlapping Time Zone Difference for Different Categories of Services

Source: based on own calculation

A similar pattern is evident for ICT-enabled services, where the goal is to expedite production, delivery, and consumption. However, requiring domestic workers to work overtime or double shifts increases production costs due to nighttime disutility. With an 8-hour time difference, the end of the workday in one country aligns with the start in another, facilitating efficient service exchange. An 8–10-hour time difference is optimal for meeting nighttime demand in one country with a daytime workforce in another. Conversely, a time difference exceeding 10 hours can negate outsourcing's time-saving benefits, as it marks the next day in the reporter's country.

It is noteworthy that services such as construction and manufacturing, which require physical movement of labour across locations, may necessitate a broader time duration. Similarly, travel and transportation services often involve extended overseas flights and long train rides. Consequently, the beneficial range of time differences is wider for less virtual services that require more physical movement.

We have conducted an in-depth analysis of the country pairs situated within the optimal time zone region for each service category. These pairs have been classified according to their level of economic development. Interestingly, South-South pairs represent the largest share for all three service categories, accounting for nearly 70%, followed by North-South pairs at around 30%. In contrast, the North-North pair makes up less than 5% (refer to Table 5). These results strongly suggest that developing countries located in non-overlapping time zones are deriving

substantial benefits from service trade. It is particularly noteworthy that the highest proportion of developing country pairs is observed in the IT-enabled services sector.

This distribution pattern implies a significant shift in the global service trade landscape, with emerging economies playing an increasingly prominent role. The predominance of South-South and North-South pairs in the optimal time zone regions suggests that the CE may be particularly beneficial for facilitating service trade between countries at different stages of economic development. To visually represent this phenomenon, we have plotted representative country pairs within the optimal time zone difference region for all three categories of services. These visualizations are presented in Figures 5, 6, and 7.

Figure 5: Example of Location of Developed and Developing Country pairs in the Optimum Time Zone Difference in case of ICT-enabled Services



Reporter and partner pairs are highlighted in the same colour.

Figure 5 represents some of the highest ICT-enabled service trading country pairs of developed and developing countries situated in optimum time zone region.

The country pairs plotted in these figures have been deliberately selected to represent a dichotomy in economic development status: each pair consists of one developing country and one developed country. These pairs were chosen from among the highest service trading partners within their optimal time difference ranges.

Aggregate Service			<b>ICT-enabled Services</b>			Travel-Transportation Services		
Cty pair*	EXP	IMP	Cty pair	EXP	IMP	Cty pair	EXP	IMP
IND-USA	54%	46%	CHN - GBR	58.81%	48.19	HKG-USA	60.8%	39.2%
HKG-USA	60.1%	39.9%	<b>RUS-</b> USA	54.34%	45.66%	SGP-USA	53.06%	46.94%
SGP-IRL	55.8%	45.2%	KOR-GBR	52.02%	47.98%	ARE-USA	58.96%	41.04%
SGP-GBR	57.09%	42.91%	KOR-NLD	51.69%	48.31%	THA-USA	70.84%	29.16%
HKG-GBR	51.9%	48.1%	IND-USA	91.84%	8.16%	PHL-USA	50.31%	49.68%

 Table 6: Export-Import Pattern between Developed and Developing Country pairs situated in

 Optimum Time Zone Region

\* Countries in bold are the developing countries. Source: OECD-WTO BaTis Dataset

Interestingly among these country pairs, the export share of developing countries consistently exceeds that of their developed counterparts (refer to Table 6). This observation is particularly pronounced in the ICT-enabled service trade sector, where Southern countries clearly dominate Northern countries in export volume.





Reporter and partner pairs are highlighted in the same colour.

Figure 6 represents some of the highest service trading country pairs of developed and developing countries situated in optimum time zone region.

Developing countries are effectively leveraging their comparative advantage in labour costs by utilizing their abundant, inexpensive, lower-skilled labour to boost service exports. This strategy enables them to compete globally despite disadvantages in technological infrastructure

and advanced human capital. Empirical evidence indicates a shift in North-South trade patterns, emphasizing the service sector. This suggests that service exports can significantly benefit emerging economies, enhancing economic development and global market integration.



Figure 7. Example of Location of Developed and Developing Country pairs in the Optimum Time Zone Difference for Travel and Transportation Service

Figure 7 represents some of the highest travel and transportation service trading country pairs of developed and developing countries situated in optimum time zone region.

The country pairs under examination are strategically positioned within optimal time zones for all three service categories, maximizing CE benefits. Developing countries contribute disproportionately to total trade flow in each pair, surpassing developed counterparts. This dominance stems from strategic time zone utilization, abundant cost-effective skilled labour, supportive government policies, and significant ICT infrastructure advancements. CE has enabled developing countries to establish competitive positions in global service trade, challenging traditional paradigms. This demonstrates CE's efficacy in facilitating economic growth in emerging markets. Service trade, optimized by CE, catalyses economic progress in developing countries, highlighting the dynamic nature of global economic interactions and the increasing significance of time zone differentials in influencing international trade patterns.

### 6. Conclusion

Theoretical literature categorizes the effects of time zone differences on trade into continuity and synchronization effects, yet empirical validation and synchronization measures are limited. This study assesses the impact of CE and SE on services trade, both in aggregate and disaggregated levels, focusing on ICT-enabled services and traditional travel-transportation services. The analysis indicates the presence of CE across all service categories and highlights the significance of good governance for ICT-enabled services. The political landscape did not significantly influence service types when infrastructure and ICT connectivity were advanced. Robust intellectual property rights (IPR) legislation is crucial for fostering market competition, efficiency, and innovation, thereby enhancing services trade. A key finding is that linguistic congruence between trading partners reduces transaction costs, facilitating service trade. Additionally, the study identifies the optimal time difference range among countries to maximize comparative advantage benefits, with ICT-enabled services having the narrowest effective time window.

This analysis reveals that developing nations actively engage in service trade, leveraging costeffective semi-skilled labour for BPO, call centres, and customer support. Remote service delivery has opened new markets, enhancing global integration. With sufficient digital infrastructure and human capital development, these countries can overcome geographical barriers, with ICT-enabled services offering substantial opportunities for economic growth and diversification.

Our analysis indicates that policymakers should focus on enhancing ICT infrastructure to improve cross-border connectivity and service delivery, promoting services trade through comparative advantages. The study highlights the crucial role of ICT and physical infrastructure in expanding service trade. The growth in service exports from developing economies underscores the need for strategic investments in these areas. Superior physical infrastructure, extensive communication systems, and effective governance are positively correlated with increased services trade. Additionally, a country's intrinsic socioeconomic factors significantly influence its choice of bilateral trading partners for services. This finding has implications for establishing successful bilateral and multilateral trade agreements, potentially facilitating greater integration of developing countries into the global economy.

The growth of international trade in services significantly advances several United Nations Sustainable Development Goals, including those related to inequality, poverty alleviation, education, and economic growth. This sector's expansion demands a more skilled workforce, leading to improved educational and vocational training and increasing employment opportunities in fields such as technology, hospitality, finance, and education. Such developments help reduce poverty and inequality and boost female labour force participation, fostering more equitable economic growth. Additionally, diversifying economic activities enhances resilience to external shocks and market volatility, potentially supporting more sustainable long-term growth.

Given these observations, it can be posited that a geographical location in non-overlapping time zones has potential to transform the negative impact of distance into a comparative advantage. This transformation is contingent upon implementation of policies aimed at strengthening digital infrastructure, improving governance, and enhancing socioeconomic fundamentals. Future research should explore how time zone differentials affect intra-industry service trade patterns and dynamics, evaluating their impact on trade efficiency and strategic advantages.

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### Appendix

A1. Variable List

Variable	Description	Year	Source
, uz andite	Dependent Variable		Soul CC
Bilateral Flow of Aggregate Services	It is measured as a summation of the exports and imports of total services among the country pair.	2018	WTO-OECD Balanced Trade in Services Dataset (BaTiS), WTO
Bilateral Flow of ICT-enabled services	It is measured as a summation of the exports and imports of ICT-enabled services among the country pair.	2018	WTO-OECD Balanced Trade in Services Dataset (BaTiS), WTO
Bilateral Flow of Travel and Transportation	It is measured as a summation of the exports and imports of travel and transportation services among the country pair.	2018	WTO-OECD Balanced Trade in Services Dataset (BaTiS), WTO
services			
771 11 66	Explanatory Variable		
Time difference	Time difference between the capitals of the country pairs based on Coordinated Universal Time, measured in minutes.		
GDP Partner	Partner country's GDP value in million USD.	2017	CEPII
GDP Reporter	Partner country's GDP value in million USD.	2017	CEPII
Intellectual Property Right (IPR)	The Intellectual Property Rights component evaluates the protection of intellectual property. In addition to an opinion-based measure of the protection of intellectual property, it assesses protection of two major forms of intellectual property rights (patents and copyrights) from de jure and de facto perspectives, respectively. It has three components: (a) Protection of Intellectual Property Rights; (b) Patent Protection; (c) Copyright Piracy.	2017	Property Rights Alliance
Government effectiveness	The quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	2017	World Governance Indicators (WGI)
Political Stability and Absence of Violence/Terrorism	The perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.	2017	World Governance Indicators (WGI)
Broadband	Average of broadband internet subscriptions per 100 population between partner and reporter countries.	2017	World Bank
Mobile	Average of Mobile cellular telephone subscriptions per 100 population between Reporter and Partner countries.	2017	World Bank
GFCF	Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.	2017	World Bank
FDI	These are the net inflows of investment to acquire a lasting management interest (10% or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors and is divided by GDP.	2017	World Bank
Per capita Service Value Added	It is the difference between the Service Value added per capita in terms of GDP among the country pair.	2017	World Bank
Mean Years of Schooling	The average number of years of education received by people ages 25 and older in their lifetime, based on education attainment levels of the population converted into years of schooling. It has been used by the Human Development Report Office (HDRO) of the United Nations Development Programme (UNDP) since 2010 as one of the education indicators in the calculation of the Human Development Index (HDI) (UNDP, 2010).	2017	World Bank & Human Development Report, UNDP
Common Language Index	The index is calculated based on the Common Official Language, Common Native Language, and Linguistic Proximity. The index is constructed and used by Jacques Melitz and Farid Toubal ( <i>June 2012</i> ).		Native Language, Spoken Language, Translation and Trade - Jacques Melitz and Farid Toubal; Journal of International Economics (2014)

### A.2. Poisson Pseudo Maximum Likelihood (PPML) Model

The log-likelihood function of  $y_i$ , which follows a Poisson distribution with parameter,  $\lambda_i = e^{x'_i\beta}$  for i = 1, 2, 3, ..., n is,

$$l(\beta) = \sum_{i=1}^{n} \left( y_i \, e^{x_i'\beta} - e^{x_i'\beta} - \log\left(y_i!\right) \right);$$

Where,  $x_i$  is a  $(1 \times K)$  vector, and  $\beta$  is a  $(K \times 1)$  vector.

The Score vector is,

$$S(\beta) = \frac{\partial l(\beta)}{\partial \beta} = \sum_{i=1}^{n} (y_i - e^{x'_i \beta}) x_i$$

The Hessian Matrix is negative definite, and it is given below,

$$H(\beta) = \left(\frac{\partial^2 l(\beta)}{\partial \beta \partial \beta'}\right) = -\sum_{i=1}^n e^{x_i'\beta} x_i x_i'$$

Note,  $S(\beta) = 0$  does not have any closed form solution. Hence, MLE of the coefficients is obtained by numerically solving,  $S(\beta) = 0$ . The Hessian matrix is used to calculate the Fisher information matrix, and subsequently the variance-covariance matrix of  $\beta$ ,  $\Omega$  (see, Gourieroux, Monfort, & Trognon, 1984). Note,

$$\sqrt{n}(\hat{\beta}_{MLE}-\beta)\sim AN(0,\Omega)$$

This model yields consistent estimates of,  $\lambda_i = e^{x_i'\beta} = E(y_i|x_i)$ ; i = 1,2,3...,n.